



Electrons

$$e = -1.6 \times 10^{-19} \text{ coulombs (c)}$$

$$e = 9.11 \times 10^{-31} \text{ Kg}$$

$$1 \text{ coulomb} = 6.25 \times 10^{18} e$$

$$F_e = \frac{kQ_1Q_2}{d^2} = qE$$

Coulomb's Law

F_e = force between the 2 objects
 k = constant = $9 \times 10^9 \frac{Nm}{C^2}$
 Q_1, Q_2 = charge of object 1 & 2 (C)

Surface Area of a sphere = $4\pi r^2$

Electric Field Strength

Force per coulomb exerted on a test charge at that point



$$E = \frac{F}{q} = \frac{kQ}{d^2} = \frac{V}{m} \text{ also } E = \frac{V}{m} = \frac{V}{d}$$

$$F_e = qE$$

E = electric field strength (N/C) (NC⁻¹) (V/m)
 In the same direction as F_e if Q is positive

Electric Potential near point charge Q

$$V_1 = \frac{kQ}{d_1} \quad V_2 = \frac{kQ}{d_2}$$

Potential V of surface of a sphere $V = \frac{kQ}{r}$

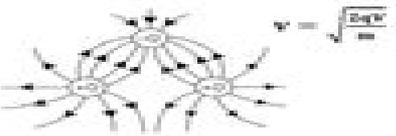
ELECTRIC POTENTIAL DIFFERENCE

(Work (Joules) needed to move charge between 2 points)

$$\Delta V = \frac{W}{q} = \frac{\text{Joules}}{\text{Coulomb}} = \frac{Nm}{C} = V_2 - V_1 = Ed$$

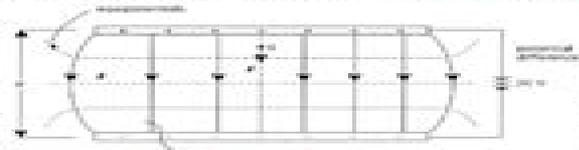
HENCE $\frac{V}{m} = \frac{N}{C} = E$

ENERGY METHOD $W = qV = qEd = \frac{1}{2}mv^2$



$$v = \sqrt{\frac{2qV}{m}}$$

Parallel oppositely charged plates UNIFORM



$$E(\text{Vm}^{-1}) = \frac{\text{Volts}}{\text{metre}} = \frac{V}{d} = \frac{F_e}{q} = \frac{kQ}{d^2}$$

$$V = Ed = \frac{W}{q} \quad w = qed$$

$$F_e = \frac{kQ_1Q_2}{d^2} = qE$$

FORCE METHOD $a = \frac{F_e}{m} = \frac{qE}{m}$

$$v^2 = u^2 + 2as \quad t = \frac{v}{a} \quad s = ut + \frac{1}{2}at^2$$

$$v = \sqrt{2as} = \sqrt{\frac{2qE_s}{m}} = \sqrt{\frac{2F_e s}{m}}$$

MILIKANS LAW (in suspension)

$$F_e = Eq = F_w = mg$$

$$q = \frac{mg}{E}$$

ELECTRON GUN

$$q_e \times V = \frac{mv^2}{2} \rightarrow v = \sqrt{\frac{2 \times q_e \times V}{m}}$$

$$I = \frac{Q}{t} = \frac{q}{t} = nqv$$

$$V = IR = \frac{qR}{t} = nqvR = EMF$$

$$R = \frac{V}{I} = \frac{Vt}{q} = \frac{V}{nqv}$$

Ohm's Law

I = Electric current (Amps) (rate of flow of charges with time)

R = Resistance of wire (Ohms)(Ω) (Volt/amp) (Dependent on temperature $T \uparrow R \uparrow$)

V = EMF voltage = the force moving q (V) (EMF)

v = d drift velocity (m/s)

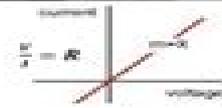
n = number of d per metre

$$R \propto L \quad R = \frac{L}{A} \quad R = \rho \frac{L}{A}$$

ρ = Resistivity of wire (Ω/m)

L = Length of wire

A = cross sectional area = πr^2



- I(+) + -> CONVENTIONAL CURRENT pos -> neg

Junction Law

$$I_1 = I_2 + I_3$$

RESISTORS IN SERIES

$$R_T = R_1 + R_2 + R_3 + R_4$$



RESISTORS IN PARALLEL

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$



Loop Law

$$V - V_1 + V_2 + V_3 = 0$$

$$V = V_1 + V_2 + V_3$$



Lower Resistance = Thicker Filament

POWER (Watts) Rate of energy transfer

$$P = \frac{\text{Energy (w)}}{t} = \frac{qV}{t} = IV = \frac{V^2}{R} = I^2R$$

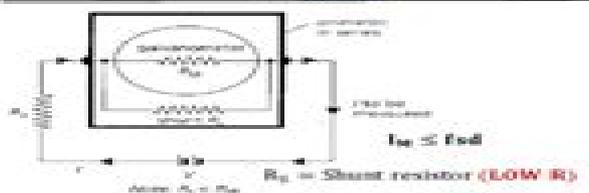
$$R = \frac{P}{I^2} = \frac{qV}{It^2} = \frac{V^2}{P} = \frac{V^2 t}{w} = \frac{Vt}{q} = \frac{V}{I}$$

$$I = \frac{P}{V} = \frac{w}{IV} = \frac{q}{t} = \frac{C}{s} = \pm \sqrt{\frac{P}{R}} \text{ OR } \sqrt{\frac{qV}{tR}} = \frac{V}{R}$$

$$V = \frac{P}{I} = \frac{Pt}{q} = \frac{w}{q} = \frac{w}{q} = \frac{I}{C} = \frac{Nm}{C} = \pm \sqrt{RP} = \frac{qR}{t} = IR$$

$$W = qV = \frac{V^2 t}{R} = I^2 R t = Pt = IVt = \frac{1}{2}mv^2$$

Efficiency = $\frac{\text{Power in}}{\text{Power out}} \times 100$



R_2 = Shunt resistor (LOW R)

$$I_s \times R_2 = I_{se} \times R_{se}$$

$$I_{se} = I_s + I_g$$

$$R_2 = \frac{I_g \times R_{se}}{I_{se} - I_g}$$



R_2 = series resistor (HIGH R)

$$V = I_{se} \times (R_2 + R_{se})$$

THERMISTORS

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Benjamin Loewy



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